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Exploring the Stratospheric Ozone

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Lesson Plan #2

Grade Level(s)/Subject(s) Taught: 9th and 10th/Math/Science

- ❖ I have attached an example of the data set for this lesson on an excel worksheet. This would actually be imported into the TI-84 calculator, but unfortunately I was having some computer issues with TI-Connect so I do not have a sample of that data screen. The data is the same on the excel worksheet so I have provided that as a substitute.
- ❖ I have attached a reference sheet for using the TI-84 calculator for this lesson. This sheet could be handed out to students or put on an overhead as a visual aid

Validation of Stratospheric Ozone

Objectives:

- Understand what different concentrations of atmospheric ozone mean for life on Earth
- Relate stratification to atmospheric ozone concentration
- Validation of satellite data

Scientific Concept:

- Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.
- Students will use graphing calculator to collect and display data.
- Students will use linear regression function of the graphing calculator to analyze data.

Background:

This lesson requires familiarity with importing data into a graphing calculator. It also requires familiarity with statistical analysis using a graphing calculator. I would start this lesson with a review of the vocabulary terms that are necessary for understanding and completing the assignment. These terms include (but are not limited to):

- ozone
- ozone layer
- ozonesonde
- SAGE III
- stratosphere
- validation

Launch:

Over the past decade, the levels of ozone in the atmosphere have received a lot of media and government attention. Major focus has centered on the hole or area of depletion of the ozone layer over the Artic and Antarctic poles in winter months.

To better understand the complex interactions taking place in the atmosphere, scientists have designed satellites to take precise measurements of ozone and aerosols in the stratosphere. In order for scientists to know if the satellite data are reliable, the data must undergo a process known as validation. Validation requires that data measured by other means be used in comparison with the satellite data. For ozone validation, ozonesonde data is used.

(This lesson uses SAGE III satellite data and ozonesonde data captured over Thule, Greenland on October 26, 2002. Of major importance is how well the satellite compares to the ozonesonde data. The graph, accessed via the links section, shows how SAGE III corresponds to the ozonesonde data. For the lesson, only data from the stratosphere is used.)

Lesson Procedure:

- Step 1: Depending on my class, I would either import the data into the graphing calculators prior to class or have students import the data into the calculator manually until all data points are in the calculators. This would depend on the class makeup, time schedule, availability of graphing calculators, etc. (Example of data set attached to lesson)
- Step 2: Once students have the data in their graphing calculator they would use the calculator's Linear Regression function to find the equation of the line that best fits the graph. (This is a skill we will have covered. If necessary, teacher can model this on the overhead to review this function of the calculator with students. In addition, students will have access to step-by-step instruction on using this functionality refer to USING THE LINEAR REGRESSION FUNCTIONALITY ON A GRAPHING CALCULATOR worksheet.)
- Step 3: Students should have a linear regression for both sets of data, so they will have to repeat step 2 for the second set of data.
- Step 4: Students will use the data and graphs in their TI- 84 calculators to answer the questions on the student worksheet. Students may do this in groups. Extension questions are provided for students that may finish faster than others.

In order to close the lesson I would bring the class back together and have some students display their graphs in the front of the classroom using the overhead connection for the calculator. Using these models, we would review the answers students got for the student worksheet.

Student Worksheet

Questions:

1. Looking at the graphs, in general, what is happening to the concentration of ozone in the troposphere? In the stratosphere?

2. Is the slope positive or negative? What does the positive or negative slope say about the ozone concentrations?

3. You wrote down each graph's linear regression. This linear regression provides the coefficients (a and b) of a straight line which approximates the data. Looking at the slope coefficients (a) of each graph, do you think that the slopes are close to each other? What does that mean? What can you infer about the actual data?

4. In comparing the graphs, do you think that the satellite does a good job of capturing the data that the ozonesonde captures? Are the graphs similar or dissimilar? Do you think the satellite provides good 'accurate' data?

Extensions:

1. What do you think would happen if the Earth didn't have the ozone layer? How would life as you know it change? Plants, animals, humans, water.

2. What do you think will happen if the hole in the ozone over the Artic and Antarctic continues to grow? What would happen if a hole appeared over where you live?

3. If you went to another planet that didn't have an ozone layer, what do you think could be done to protect yourself? What types of things would have to be developed?

Rubric: The student's class work grade will be determined based on the following rubric. The students will be aware of this rubric, and it will be posted for them to refer to.

5: Student was on task 85 – 100 % of the time. Student worked productively with the TI-84 calculator to answer all questions correctly.

4: Student was on task 70 – 85 % of the time. Student worked productively with the TI-84 calculator to answer correctly at least 3 questions.

3: Student was on task about 50 – 70 % of the time. Student worked with the TI-84 calculator to come up with conclusions and answer correctly at least one question.

2: Student was on task less than half of the time. Student worked with the TI-84 calculator to come up with conclusions and answers that are not complete.

1: Student was not on task for any significant amount of time. Student worked with TI-84 calculator but did not come to any conclusions.

0: The student refused to participate in the activity or did not complete the activity.